

A RE-EVALUATION OF THE OPISTOCYSTIDAE
(OLIGOCHAETA) WITH DESCRIPTIONS
OF TWO NEW GENERA

Walter J. Harman and Michael S. Loden

Abstract.—A comparison of the genital characters of three species of Opisthocystidae has required the formation of two additional genera. *Crustipellis* gen. nov. is erected for the placement of *Opisthocysta tribranchiata* Harman, 1969, and *Trieminentia* gen. nov. for *Opisthocysta corderoi* Harman, 1969. The reproductive system of *C. tribranchiata* is described. *Opisthocysta serrata* Harman, 1969 is declared a *species incerta sedis*. A key to immature individuals of Opisthocystidae is provided.

Opisthocysta tribranchiata Harman, 1969, was described from sexually immature individuals from Mississippi and Louisiana. This was the second species of Opisthocystidae to be found in North America, the first being *Opisthocysta flagellum* (Leidy), which Harman (1969) relegated to the status of *species inquirenda*.

Since the description of *O. tribranchiata*, its range has been extended somewhat; specimens in the Louisiana State University collection referable to this species have been collected from North Carolina, Florida and central Mexico. The distribution of the Opisthocystidae in North America appears restricted to the eastern and southeastern United States and Mexico. Records from the literature place *Pristina flagellum* (= *O. flagellum*) in Illinois (Smith, 1900), Tennessee (Collins, 1937) and Virginia (Falls, 1975). In each case, however, the diagnosis was either inadequate for modern species placement, or was lacking.

A collection from Madison County, Mississippi, 5 June 1975, contained 4 sexually mature individuals of *O. tribranchiata*, as well as several additional immature specimens. Based on the positions of the gonads and the associated reproductive structures revealed by serial sectioning and their comparison to features of other known species of Opisthocystidae, a re-evaluation of this family is warranted.

Gates (1974) stated that somatic characters are more conservative than genital characters in megadriles. This is certainly the situation in the Opisthocystidae, where the known species are almost identical in the sexually immature stages, each bearing the characteristic 3 caudal appendages, a prostomial extension, and dorsal setal bundles containing hair setae from segment II. The species differ by setal measurements, presence or absence of needle setae, and serrations on the hairs, among other characters.

In mature worms, however, the variation in the location and structure of the reproductive apparatus are considerably different.

Only a few oligochaete families (such as the Naididae) have specific or even generic differences recognizable in immature individuals. In other monogeneric families, such as the Phaeodrilidae and the Sparganophilidae, the differences in reproductive anatomy among the known species are by no means as great as those among the presently recognized species of *Opistocysta*. In genera where the location of the reproductive segments differs consistently from the remainder of the family (e.g. *Aulodrilus* in the Tubificidae, *Pristina* in the Naididae), subfamilial separations are recognized. Anterior displacement of genitalia by one or 2 segments is well documented in the Oligochaeta, but not to the extent found in Opistocystidae. Differences in the construction of the male reproductive tracts on a par with those of the Opistocystidae are major considerations for generic differentiation in other oligochaete families (e.g. Tubificidae). It is therefore proposed, as was suggested by Harman (1969) and Brinkhurst (1971), that new genera be erected in the Opistocystidae to reflect the differences in the location and structure of the genital apparatus of the known species.

Taxonomy

The erection of additional genera unfortunately must result in excluding 2 of the 5 species of *Opistocysta*. *Opistocysta flagellum* is a *species inquirenda* (Harman, 1969), as the result of Leidy's (1880) presently inadequate description; the continuation of this species in that status is desirable. *Opistocysta serrata* Harman, which was described from immature individuals, must now be collected and examined in the sexually mature form before proper generic placement can be determined; it is hereby declared a *species incerta sedis*, but left in *Opistocysta* pending description of its genitalia.

Family OPISTOCYSTIDAE Cernosvitov, 1936

Type-genus.—*Opistocysta* Cernosvitov, 1936.

Diagnosis.—Eyeless: Prostomium formed into a proboscis. Three ciliated caudal appendages: 2 longer ventro-laterals and one shorter dorso-median. Dorsal setae from II consisting either of hair setae or of hair and needle or needle-like setae. Ventral setae bifid crotchets. Testes and ovaries paired but may be diffuse in the reproductive state; testes one segment anterior to the ovaries. Sperm funnels in septum posterior to testes segment, atria and penes in segment with ovaries. Spermathecae one segment posterior to atria and ovaries. Asexual reproduction by budding; 5 segments formed anteriorly.

Opistocysta Cernosvitov, 1936

Type-species.—*Opistocysta funiculus* Cordero, 1948.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II, consisting of hair setae or hair and needle setae. Testes and male funnels in XXI, atria and ovaries in XXII. Atria covered by diffuse prostate; eversible penes. Spermathecae in XXIII.

Opistocysta funiculus Cordero, 1948

Fig. 1

Opistocysta flagellum.—Cernosvitov, 1936.—Marcus, 1944.—duBois-Reymond Marcus, 1947.

Opisthocysta funiculus Cordero, 1948.—duBois-Reymond Marcus, 1949.—Brinkhurst, 1966; 1971.—Brinkhurst and Cook, 1966.—Harman, 1969.

Diagnosis.— $l = 5-12$ mm. $s = 40-106$. Prostomium forming a proboscis up to $785\ \mu\text{m}$ long. Three caudal appendages: ventro-laterals longer and thicker than dorso-median, frequently asymmetrical. Dorsal setae begin in II, consisting of 2-3 simple-pointed needles and 2-3 hairs per bundle; needles with a nodule, $90-105\ \mu\text{m}$ long; hairs $150-160\ \mu\text{m}$ long with thick serrations. Ventral setae 3-5 per bundle with the distal tooth longer and thinner than the proximal; lengths $120\ \mu\text{m}$ in II, $104\ \mu\text{m}$ in III-V, $116-120\ \mu\text{m}$ midbody, $128-130\ \mu\text{m}$ posteriorly; nodule median in II-V, distal posteriorly. Clitellum milk-white in living worms; XXI-23/24; saddle-shaped anteriorly, encircling the body on XXIII. Testes in XXI; ovaries in XXII. Sperm funnels on septum 21/22; atria oval with diffuse prostate; penes eversible; male pores in XXII. Spermathecae paired in XXIII; spermathecal pores open ventrally just posterior to septum 22/23.

Distribution.—Argentina, Brazil, Africa (?).

Opistocysta serrata Harman, 1969, species incerta sedis

Pristina flagellum.—Michaelsen, 1905.

Opisthocysta flagellum (part).—Cordero, 1948.

Opistocysta serrata Harman, 1969.—Brinkhurst, 1971.

Distribution.—Paraguay.

Opistocysta flagellum (Leidy, 1880), species inquirenda

Pristina flagellum Leidy, 1880.—Smith, 1900; 1918.—Collins, 1937.—Penak, 1953.

Opisthocysta flagellum, Goodnight, 1959.—Brinkhurst, 1964; 1971.—Brinkhurst and Cook, 1966.—Harman, 1969.—Falls, 1975.

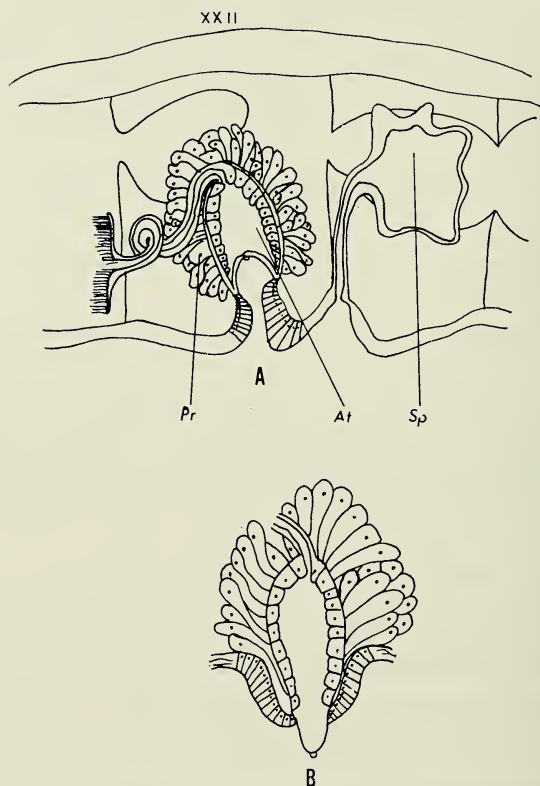


Fig. 1. Reproductive structures of *Opistocysta funiculus*. (After Cernosvitov, 1936.) A: Penis within atrial cavity. B: Penis everted. At: atrium, Pr: prostate, Sp: spermatheca.

Trieminentia gen. nov.

Type-species.—*Opistocysta corderoi* Harman, 1969.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II consisting of hairs and possible needles. Testes and male funnels in XIV or XV, atria and ovaries in XV or XVI. Proximal position of atria with thickened walls and diffuse prostate. Eversible pseudopenes. Spermathecae in XVI or XVII. Sexual reproduction by budding, 5 segments formed anteriorly.

Etymology.—So named because of the three caudal projections.

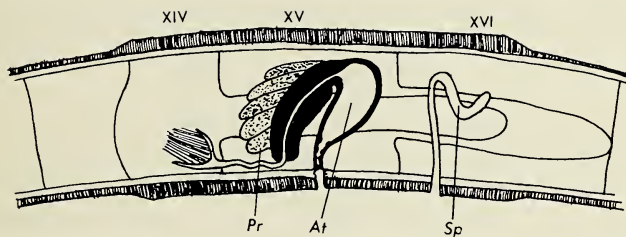


Fig. 2. Reproductive structures of *Trieminentia corderoi*. (After Cordero, 1948.) At: atrium, Pr: prostate, Sp: spermatheca.

Trieminentia corderoi (Harman, 1969)

Fig. 2

Opisthocysta flagellum, Cordero, 1948.

Opistocysta corderoi Harman, 1969.—Brinkhurst, 1971.

Diagnosis.— $l = 10\text{--}12$ mm. $s = 56\text{--}76$. $n = 22\text{--}23$. Prostomium forming a proboscis ca. $660\text{ }\mu\text{m}$ long. Three caudal appendages: laterals up to $900\text{ }\mu\text{m}$ long, $150\text{ }\mu\text{m}$ wide at base; median ca. $190\text{ }\mu\text{m}$ long, $72\text{ }\mu\text{m}$ wide. Foreign matter adhering to cuticle. Dorsal setae begin in II, consisting of unserrated hairs, 2 per bundle, $72\text{ }\mu\text{m}$ long in III, up to $360\text{ }\mu\text{m}$ in XII–XII, and 1–2 needles(?), ca. $30\text{ }\mu\text{m}$ long. Ventral setae 4–5 per bundle, ca. $80\text{ }\mu\text{m}$ long; distal tooth thinner than proximal; distal nodulus. Clitellum whitish, encircling the body, XV–XVI. Testes in XIV or XV, ovaries in XV or XVI. Sperm funnels on 14/15 or 15/16. Proximal portion of atria with thickened walls, reflexed, with diffuse prostate on anterior surface. Median portion of atria with abrupt expansion and thin walls; distal portion constricted, forming eversible pseudopenes. Male pores in XV or XVI, female pores in XV or XVI, paired, opening in a groove in the clitellum. Spermathecae in XVI.

Distribution.—Uruguay. New Record: Costa Rica, Heredia Province, ca. 1 mi NE Los Chiles. 8 July 1965. K. A. Arnold (LSU 1262).

Comments.—Immature specimens collected from Costa Rica agree in every detail with the characteristics (setal lengths, etc.) given by Harman (1969). Cordero (1948) states that although there were no needle setae present, the hairs were unequally long. In specimens in this collection there are isolated segments free of external foreign matter where there are 1–2 hair setae extending beyond the body wall and 1–2 additional setae within the body wall. The latter are not, in all cases, distinguishable from replacement hairs, but there is a strong possibility that they are extremely

fine, simple-pointed needles with a distal tapering nodulus that rarely extend beyond the body wall and its coat of adhering foreign matter.

Crustipellis, gen. nov.

Type-species.—*Opistocysta tribranchiata* Harman, 1969.

Diagnosis.—Prostomium forming a proboscis. Three ciliated caudal appendages. Dorsal setae from II consisting of hairs and needles. Testes and male funnels in XI. Atria and ovaries in XII. Diffuse prostate covering atrium. Protrusible penes. Spermathecae in XIII. Asexual reproduction by budding, 5 segments formed anteriorly.

Etymology.—Refers to the encrustation of foreign matter on the body wall.

Crustipellis tribranchiata (Harman, 1969)

Fig. 3

Opistocysta tribranchiata Harman, 1969.—Brinkhurst, 1971.

Diagnosis.— $l = 1.7\text{--}2.9\text{ mm}$. $s = 15\text{--}30$. $n = 18\text{--}19$. Prostomium forming a proboscis up to $180\text{ }\mu\text{m}$ long. Three caudal appendages: ventro-laterals up to $300\text{ }\mu\text{m}$ long, $70\text{ }\mu\text{m}$ wide; dorso-median to $90\text{ }\mu\text{m}$ long, $30\text{ }\mu\text{m}$ wide. Dorsal setae from II, 1–4 hairs and 1–4 needles per bundle. Hairs finely serrated (ca. $2\text{ }\mu\text{m}$ apart), $155\text{--}370\text{ }\mu\text{m}$ long; needles simple-pointed, without a nodulus, $35\text{--}65\text{ }\mu\text{m}$ long. Ventral setae 3–5 per bundle (usually 4), $70\text{--}87\text{ }\mu\text{m}$ long, with the distal tooth thinner and longer in anterior segments, with the teeth approaching equal length posteriorly. Clitellum XI or 11/12 to XIII or XIV, saddle-shaped. Testes in XI, ovaries in XII. Sperm funnels on 11/12. Atria in XII, pear-shaped, covered with diffuse prostate. Penes well formed, protrusible. Male pores in XII. Spermathecae in XIII.

Distribution.—Louisiana, Mississippi. New records: 1. Mexico: Veracruz; 11.7 mi S Rio Tecolutla—Mex 180. 29 December 1974. R. M. Blaney & P. K. Blaney (LSU 1419).—2. Florida: Citrus Co. Pond along Fla. 200. 1.8 mi NE Hernando. 6 September 1975. W. J. Harman & M. S. Loden (LSU 1466).—3. Florida: Alachua Co. roadside ditch along I-75. 1.8 mi N jct I-75 and Fla. 200. 6 September 1975. W. J. Harman & M. S. Loden (LSU 1467).—4. North Carolina: Chatham Co. Buckhorn Creek. 13 October 1973. M. S. Loden (LSU 1842).

Comments.—This description incorporates information on *C. tribranchiata* collected since the original description. Harman (1969) judged needle setae to be absent; the cuticle of this species, like *T. corderoi* has an affinity for foreign matter, which often obscures the surface of the body, and renders an analysis of the setae most difficult. Since the species was originally described several specimens have been collected that have needle-like setae

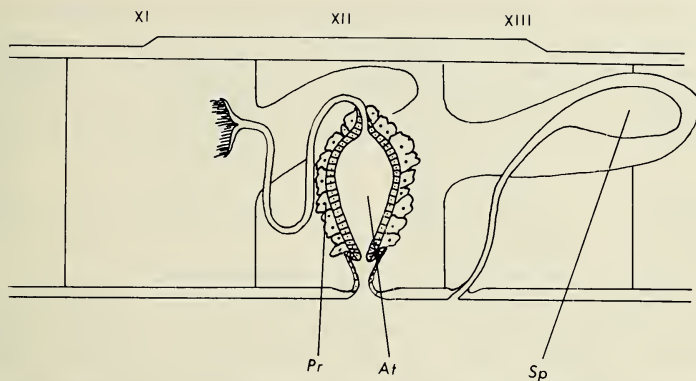


Fig. 3. A reconstruction of the genital segments of *Crustipellis tribranchiata*. At: atrium, Pr: prostate, Sp: spermatheca.

evident in the dorsal bundles. These setae are relatively stable in length, and it is now judged that the dorsal bundles contain simple-pointed needle setae that lack a nodulus.

Discussion

A reconstruction of the reproductive system of *C. tribranchiata* is presented in Fig. 3. The clitellum extended from near the middle of segment XI to the middle of XIII; it covered the worm dorsally and laterally to just above the ventral setae. (One sexually mature specimen from Mexico had the clitellum from intersegmental groove 11/12 to the middle of segment XIV, but other visible genital characters, including the location of the genital pores, of this whole-mount specimen were as in the Mississippi material.) The testes were in segment XI; although no compact structures identifiable as paired testes were present, the coelom of segment XI was virtually filled with spermatozoa. The sperm sac was formed from septum 11/12 and extended to a point just anterior to septum 12/13.

The male ducts were paired. The funnels were located dorso-laterally just anterior to septum 11/12. The vasa deferentia descended along the posterior to walls of the septum, and ascended prior to joining the atria at their mid-dorsal surface. The atria were pear-shaped, thin-walled, and covered by a diffuse prostate. The ventral lips of the atria formed the penes. The paired male pores were in the line of the setae at either side of mid-ventral.

The ovaries were located in segment XII, but as with the testes, no compact gonadal mass was evident; the coelom contained developing ova. No oviduct could be distinguished. The ovisac was formed from septum 12/13 and extended posteriorly to segment XIV.

Table 1. Location of genital structures of known species of Opistocystidae.

	<i>Opistocysta funiculus</i>	<i>Trieminentia corderoi</i>	<i>Crustipellis tribranchiata</i>
Clitellum	XXI-XXIII	XIV-XIX	XI-XIV
Testes	XXI	XIV or XV	XI
Ovaries	XXII	XI or XIV	XII
Spermathecae	XXIII	XVI or XVII	XIII

The spermathecae were paired and located in segment XIII. The ampullae were within the ovisac, extending posteriorly to segment XIV. The ducts entered segment XIII, and the spermathecal pores were just posterior to septum 12/13. Spermatozoa were within the ampullae, but no organized spermatozeugmata could be detected.

Of 5 described species of *Opistocysta*, the genital structures of only 2 species other than *C. tribranchiata* are known. The genitalia of *O. funiculus* were described by Cernosvitov (1936) as being those of *O. flagellum*. Those of *T. corderoi* were described by Cordero (1948), also as being those of *O. flagellum*.

The differences among the locations of the reproductive structures of the species of Opistocystidae differ greatly (Table 1). As much as 10 segments separate 2 of the species.

The structures of the male reproductive tract differ considerably among the 3 species (summarized in Table 2). Both *C. tribranchiata* and *O. funiculus* have thin-walled atria covered by diffuse prostate, but the latter differs in the structure and function of the penes (Fig. 1). In *O. funiculus* the penes are eversible; according to Cernosvitov's diagram, the penes are thin-walled organs that are normally held within the atrial cavities, and evaginated during copulation (Figs. 1A and B). In *C. tribranchiata* the penes are formed from the ventral lips of the atria, have thicker walls, and are protrusible. These species differ also in the histological composition of the penial chambers. In *O. funiculus* a layer of columnar epithelium lines a chamber, while in *O. tribranchiata* a chamber is lined by squamous epithelium that apparently allows for the collapse of the chamber during penial protrusion.

The differences between *C. tribranchiata* and *T. corderoi* are similarly considerable. In *T. corderoi* the clitellum encircles the body rather than covering only the dorsal and lateral surfaces as does the clitellum of *C. tribranchiata* and the anterior portion of the clitellum of *O. funiculus*. The illustration of *T. corderoi* by Cordero (Fig. 2) shows a pseudopenis, a non-preformed eversible portion of the male duct (Stephenson, 1930), formed from the distal part of the atrium and of a different structure from the protrusible true penes of *C. tribranchiata*. Another unique feature of

Table 2. Characters of the male reproductive apparatus of the known species of Opistocystidae.

	<i>Opistocysta funiculus</i>	<i>Trieminentia corderoi</i>	<i>Crustipellis tribranchiata</i>
Penis	eversible	eversible pseudopenes	protrusible
Atrium	thin, oval	reflexed, thick- walled proximally	thin, pear- shaped
Prostate	covers atrium	proximal part of atrium	covers atrium

T. corderoi is the shape of the atrium; the proximal part is reflexed, approaching the ventral body wall. The wall of the proximal part is thickened, with prostate tissue on the anterior surface. In *O. funiculus* and *C. tribranchiata* the atria are thin, covered with prostate tissue; both species have the vasa deferentia entering dorsally.

Key to Immature Individuals of Opistocystidae

1. Hair setae serrated 2
 – Hair setae smooth *Trieminentia corderoi*
2. Dorsal bundles with both hair and needle setae 3
 – Dorsal bundles with hair setae only *Opistocysta serrata*
(*sp. incerta sedis*)
3. Ventral seta 70–87 μm long; needle setae 35–65 μm long, without
 a nodule *Crustipellis tribranchiata*
 – Ventral setae 104–130 μm long; needle setae 90–105 μm long, with
 a nodule *Opistocysta funiculus*

Literature Cited

- Brinkhurst, R. O. 1964. Studies on the North American aquatic Oligochaeta. I. Naididae and Opistocystidae. *Proc. Acad. Nat. Sci. Philadelphia* 16(5):195–230.
- . 1966. A contribution towards a revision of the aquatic Oligochaeta of Africa. *Zool. Africana* 2:131–166.
- . 1971. Family Opistocystidae. Pp. 640–646 in: R. O. Brinkhurst and B. G. M. Jamieson eds., *Aquatic Oligochaeta of the World*. University of Toronto Press.
- Brinkhurst, R. O., and D. G. Cook. 1966. Studies on the North American aquatic Oligochaeta. III. Lumbriculidae and additional notes and records of other families. *Proc. Acad. Nat. Sci. Philadelphia* 118(1):1–33.
- Cernovitov, L. 1936. Oligochaeten aus Sudamerika. *Systematische Stellung der *Pristina flagellum** Leidy. *Zool. Anz.* 113:75–84.
- Collins, D. S., Jr. 1937. The aquatic earthworms (Microdrili) of Reelfoot Lake. *J. Tennessee Acad. Sci.* 12:188–205.

- Cordero, E. M. 1948. Zur Kenntnis der Gattung *Opisthocysta* Cern. (Archioligochaeta). *Comm. Zool. Mus. Montevideo* 2(50):1-8.
- Falls, E. Q. 1975. A taxonomic survey of freshwater oligochaetes from the Richmond, Virginia area with reference to commensal ciliates. *Virginia Jour. Sci.* 26:26-29.
- Gates, G. E. 1974. On oligochaete gonads. *Megadrilogica* 1(9):1-4.
- Goodnight, C. J. 1959. Oligochaeta. Pp. 522-537 in: W. T. Edmondson, ed., *Fresh-Water Biology*, 2nd Ed. John Wiley & Sons, Inc., N.Y., 1248 pp.
- Harman, W. J. 1969. Revision of the family Opistocystidae (Oligochaeta). *Trans. Amer. Micros. Soc.* 88:472-478.
- Leidy, J. 1880. Notice of some aquatic worms of the family Naididae. *American Nat.* 14:421-425.
- Marcus, E. 1944. Sobre Oligochaeta límnicos do Brasil. *Bol. Fac. Filos. Cien. Let. Univ. Sao Paulo* 8:5-136.
- Marcus, E. duBois-Reymond. 1947. Naidids and tubificids from Brazil. *Comun. Zool. Mus. Hist. Nat. Montevideo* 2(44):1-18.
- . 1949. Further notes on naidids and tubificids from Brazil. *Comun. Zool. Mus. Hist. Nat. Montevideo* 3(51):1-11.
- Michaelsen, W. 1905. Zur Kenntnis der Naididen. *Zoologica*, 18:350-361.
- Pennak, R. W. 1953. *Fresh Water Invertebrates of the United States*. Ronald Press Co., N.Y. Pp. 292-293.
- Smith, F. 1900. Notes on species of North American Oligochaeta. III. List of species found in Illinois, and descriptions of Illinois Tubificidae. *Bull. Ill. St. Lab. Nat. Hist.* 5:441-458.
- . 1918. Aquatic earthworms and other bristle-bearing worms (Chaetopoda). P. 640 in: H. B. Ward and G. C. Whipple, eds., *Fresh-Water Biology*. John Wiley & Sons, Inc., N.Y.

Department of Zoology, Louisiana State University, Baton Rouge, Louisiana 70808.